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TITLE: Method of resist stripping during semiconductor device fabrication
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INVENTOR-INFORMATION:

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CLAIMS:

What is claimed and desired to be secured by United States Letters Patent is:

1. A method of resist stripping during semiconductor device fabrication, the method comprising:
providing a semiconductor substrate with a resist material formed thereon;
positioning the semiconductor substrate in a sealed chamber in communication with a plasma generating source;
passing a gaseous material comprising a reducing agent through the plasma generating source to produce a plasma stream wherein the plasma stream produces a reducing environment in the sealed chamber; and
directing the plasma stream at the semiconductor substrate and then exposing the resist material to another plasma stream with an oxidizing agent that produces an oxidizing environment in the sealed chamber to remove the resist material from the semiconductor substrate.

2. The method of claim 1, wherein the semiconductor substrate is a silicon wafer.

3. The method of claim 1, wherein the resist material is a polymeric **photoresist**.

4. The method of claim 1, wherein the reducing agent is present in the gaseous material an amount from about 100 to about 3000 standard cubic centimeters.

5. The method of claim 1, wherein the reducing agent is selected from the group consisting of ammonia, hydrazine, and mixtures thereof.

6. The method of claim 5, wherein the gaseous material further comprises a gas component selected from the group consisting of water, oxygen, and mixtures thereof.

7. The method of claim 5, wherein the gaseous material further comprises a gas component selected from the group consisting nitrogen, argon, carbon

tetrafluoride,
and mixtures thereof.
8. The method of claim 1, wherein the plasma generating source produces the plasma
stream by directing microwave energy at the gaseous material.
9. The method of claim 1, wherein the sealed chamber has a pressure of from about
0.5 to about 5 Torr.
10. The method of claim 1, wherein the semiconductor substrate is at a temperature
from about 100.degree. C. to about 350.degree. C.
11. The method of claim 1, wherein the plasma stream is directed at the
semiconductor substrate for a period of time from about 10 seconds to about 10
minutes.
12. A method of resist stripping during semiconductor device fabrication,
comprising the steps of:
providing a semiconductor substrate with a resist material formed thereon;
positioning the semiconductor substrate in a sealed chamber in communication with a
plasma generating source;
providing a gaseous mixture comprising a reducing agent and water, the reducing
agent being present in the gaseous mixture in an amount greater than or equal to the
water;
passing the gaseous mixture through the plasma generating source to produce a plasma
stream comprising reactive species of the reducing agent and water, wherein the
plasma stream produces a reducing environment in the sealed chamber; and
directing the plasma stream at the semiconductor substrate and then exposing the
resist material to another plasma stream with an oxidizing agent that produces an
oxidizing environment in the sealed chamber to strip the resist material from the
semiconductor substrate.
13. The method of claim 12, wherein the ratio of the reducing agent to water in the
gaseous mixture is greater than about 1.
14. The method of claim 12, wherein the reducing agent is selected from the group
consisting of ammonia, hydrazine, and mixtures thereof.
15. The method of claim 12, wherein the gaseous mixture further comprises a gas
component selected from the group consisting of nitrogen, argon, carbon tetrafluoride, and mixtures thereof.
16. The method of claim 12, wherein the sealed chamber has a pressure of from about
1 to about 5 Torr.
17. A method of resist stripping during semiconductor device fabrication, the
method comprising:

providing a semiconductor substrate with a resist material formed thereon;
positioning the semiconductor substrate in a sealed chamber in communication with a
plasma generating source;
providing a gaseous mixture comprising a reducing agent and oxygen, the reducing
agent being present in the gaseous mixture in an amount greater than or equal to the
oxygen;
passing the gaseous mixture through the plasma generating source to produce a plasma
stream comprising reactive species of the reducing agent and oxygen, wherein the
plasma stream produces a reducing environment in the sealed chamber; and
directing the plasma stream at the semiconductor substrate and then exposing the
resist material to another plasma stream with an oxidizing agent that produces an
oxidizing environment in the sealed chamber to strip the resist material from the
semiconductor substrate.

18. The method of claim 17, wherein the ratio of the reducing agent to oxygen in
the gaseous mixture is greater than about 1.

19. The method of claim 17, wherein the reducing agent is selected from the group
consisting of ammonia, hydrazine, and mixtures thereof.

20. The method of claim 17, wherein the gaseous mixture further comprises a gas
component selected from the group consisting of nitrogen, argon, carbon tetrafluoride, and mixtures thereof.

21. The method of claim 17, wherein the sealed chamber has a pressure of from about
1 to about 5 Torr.

22. A method of resist stripping during semiconductor device fabrication, the
method comprising:
providing a semiconductor substrate with a resist material formed thereon;
positioning the semiconductor substrate in a sealed chamber in communication with a
plasma generating source;
providing a gaseous mixture comprising a reducing agent, water and oxygen, the
reducing agent being present in the gaseous mixture in an amount greater than or
equal to the total amount of water and oxygen;
passing the gaseous mixture through the plasma generating source to produce a plasma
stream comprising reactive species of the reducing agent, water and oxygen, wherein
the plasma stream produces a reducing environment in the sealed chamber; and
directing the plasma stream at the semiconductor substrate and then exposing the
resist material to another plasma stream with an oxidizing agent that

produces an
oxidizing environment in the sealed chamber to strip the resist material from the
semiconductor substrate.
23. The method of claim 22, wherein the ratio of the reducing agent to water and
oxygen in the gaseous mixture is greater than about 1.
24. The method of claim 22, wherein the reducing agent is selected from the group
consisting of ammonia, hydrazine, and mixtures thereof.
25. The method of claim 22, wherein the gaseous mixture further comprises a gas
component selected from the group consisting of nitrogen, argon, carbon tetrafluoride, and mixtures thereof.
26. The method of claim 22, wherein the sealed chamber has a pressure of from about
1 to about 5 Torr.
27. A method of resist stripping during semiconductor device fabrication, the
method comprising:
providing a semiconductor substrate with a resist material formed thereon;
positioning the semiconductor substrate in a sealed chamber in communication with a
plasma generating source;
providing a first gaseous material including a reducing agent;
passing the first gaseous material through the plasma generating source to produce a
first plasma stream;
directing the first plasma stream at the semiconductor substrate for a predetermined
period of time;
providing a second gaseous material including an oxidizing agent;
passing the second gaseous material through the plasma generating source to produce
a second plasma stream; and
directing the second plasma stream at the semiconductor substrate for a predetermined period of time.
28. The method of claim 27, wherein the reducing agent is present in the first
gaseous material an amount from about 100 to about 3000 standard cubic centimeters.
29. The method of claim 27, wherein the reducing agent is selected from the group
consisting of ammonia, hydrazine, and mixtures thereof.
30. The method of claim 27, wherein the first gaseous material further comprises a
gas component selected from the group consisting of water, oxygen, and mixtures
thereof.
31. The method of claim 27, wherein the oxidizing agent is oxygen.
32. The method of claim 27, wherein the first and second gaseous materials further
comprises a gas component selected from the group consisting of nitrogen, argon,
carbon tetrafluoride, and mixtures thereof.
33. The method of claim 27, wherein the first plasma stream produces a reducing

environment in the sealed chamber.
34. The method of claim 27, wherein the second plasma stream produces an oxidizing
environment in the sealed chamber.
35. The method of claim 27, wherein the sealed chamber has a pressure of from about
0.5 to about 5 Torr.
36. A method of resist stripping during semiconductor device fabrication, the
method comprising:
providing a silicon wafer with a polymeric **photoresist** formed thereon;
positioning the wafer in a sealed chamber in communication with a plasma generating
source, the sealed chamber having a pressure of from about 0.5 to about 5 Torr;
providing a gaseous material comprising a reducing agent selected from the group
consisting of ammonia, hydrazine, and mixtures thereof;
passing the gaseous material through the plasma generating source to produce a
plasma stream comprising reactive species of the reducing agent, the plasma stream
producing a reducing environment in the sealed chamber;
directing the plasma stream at the semiconductor substrate and then exposing the
resist material to another plasma stream with an oxidizing agent that produces an
oxidizing environment in the sealed chamber to remove the resist material from the
semiconductor substrate.
37. The method of claim 36, wherein the reducing agent is present in the gaseous
material an amount from about 100 to about 3000 standard cubic centimeters.
38. The method of claim 36, wherein the gaseous material further comprises other
gas components selected from the group consisting of water, oxygen, and mixtures
thereof.
39. The method of claim 38, wherein the ratio of the reducing agent to the other
gas components in the gaseous material is greater than about 1.
40. The method of claim 36, wherein the gaseous material further comprises a gas
component selected from the group consisting of nitrogen, argon, carbon tetrafluoride, and mixtures thereof.
41. The method of claim 36, wherein the plasma generating source produces the
plasma stream by directing microwave energy at the gaseous material.
42. The method of claim 36, wherein the wafer is at a temperature from about
100.degree. C. to about 350.degree. C.
43. The method of claim 36, wherein the plasma stream is directed at the wafer for
a period of time from about 10 seconds to about 10 minutes.
44. A method of stripping a resist from a surface comprising:
exposing the resist on the surface to a first plasma with a reducing agent; and

then
exposing the resist on the surface to a second plasma with an oxidizing agent.
45. The method of claim 44, wherein the reducing agent is selected from the group
consisting of ammonia, hydrazine, and mixtures thereof.
46. The method of claim 44, wherein the first plasma is formed by passing a first
gaseous material comprising said reducing agent through a plasma generating source,
wherein said reducing agent is present in the gaseous material in an amount from
about 100 to about 3000 standard cubic centimeters.
47. The method of claim 46, wherein the plasma generating source produces said
first plasma by directing microwave energy at the first gaseous material.
48. The method of claim 46, wherein the first gaseous material further comprises a
gas component selected from the group consisting of water, oxygen, and mixtures
thereof.
49. The method of claim 48, wherein the first gaseous material further comprises a
gas component selected from the group consisting nitrogen, argon, carbon
tetrafluoride, and mixtures thereof.
50. The method of claim 44, wherein the oxidizing agent is oxygen.
51. The method of claim 44, wherein:
the first plasma is formed by passing a first gaseous material comprising said
reducing agent through a plasma generating source;
the second plasma is formed by passing a second gaseous material comprising said
oxidizing agent through said plasma generating source; and
the first and second gaseous materials further comprises a gas component selected
from the group consisting of nitrogen, argon, carbon tetrafluoride, and mixtures
thereof.
52. The method of claim 51, further comprising:
positioning the surface in a sealed chamber in communication with said plasma
generating source.
53. The method of claim 52, wherein the first plasma stream produces a reducing
environment in the sealed chamber.
54. The method of claim 52, wherein the second plasma stream produces an oxidizing
environment in the sealed chamber.
55. The method of claim 52, wherein the sealed chamber has a pressure of from about
0.5 to about 5 Torr.
56. The method of claim 44, wherein the surface on which the resist is situated is
a semiconductor substrate.
57. The method of claim 56, wherein the semiconductor substrate is a silicon wafer.

58. The method of claim 44, wherein the resist material is a polymeric **photoresist**.
59. The method of claim 44, wherein the surface on which the resist is situated is
at a temperature from about 100.degree. C. to about 350.degree. C.
60. The method of claim 44, wherein the resist on the surface is exposed to the
first plasma for a period of time from about 10 seconds to about 10 minutes.